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RESEARCH ARTICLE

An Underpinning of School Inequities: Asthma Absences and Lost Revenue in California Schools

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ABSTRACT

BACKGROUND: Asthma is epidemic in many locations in the United States. Asthma exacerbations pose serious health and education risks for students through school absences, school dropout, and introduction to the juvenile justice system. Accurate school district-level asthma data, currently in short supply, would enable early interventions that focus on specific geographic areas and racial and ethnic subgroups that have higher asthma prevalence.

METHODS: To support the development of better local level data systems, we used two California student databases, as well as state education and financial databases, to develop two models to estimate school absences and to extrapolate their economic impact in lost school revenue.

RESULTS: Analysis demonstrated subpopulations that are appropriate for early intervention: African American elementary school boys have 9.4 average absences per year, higher than other primary racial and ethnic groups. Students who miss ≥ 3 school days due to asthma account for \$26 million of lost revenue.

CONCLUSIONS: Accurate local level asthma data can identify subpopulations of students for whom environmental and treatment programs can be employed to reduce asthma absences and other related outcomes, and to reduce currently lost school revenues. Such programs also may diminish other asthma-related school inequities.

Keywords: asthma; pediatric asthma; pediatrics; school revenue; school absence.

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Pediatric asthma is epidemic among school-aged children in the United States. Asthma prevalence is approximately 10% for children 5 to 17 years of age.¹ Prevalence varies among racial and ethnic groups, ranging from 9% of white and Hispanic students, up to 13% of African American and American Indian students.¹ Beyond its direct health care impact, asthma is considered the chronic disease causing the highest number of school absences, leading to diminished achievement, school dropout, reduced college and career opportunities, and increased welfare and incarceration costs.²⁻⁴ In addition, asthma contributes to health and social disparities by virtue of its

disproportional prevalence among certain racial and ethnic groups, as noted above.⁵

Asthma-related school absences also lead to school district revenue losses because funding in several large states is tied to student attendance. California, Illinois, and New York, among other states, reimburse schools based on attendance. Although a few schools and districts have developed data to track local asthma-related absences,^{6,7} for the most part, actionable data at the school-district and school level are lacking. Furthermore, school district sociodemographic data are frequently inaccurate due to inadequate sample size. As a result, schools are mostly ill-prepared

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to engage in policy and program decisions related to prevention, environmental controls, and clinical interventions, much less to focus interventions on those most in need.

To overcome these limitations, we combined and triangulated data from several sources to draw a clearer picture of asthma's impact at the school district level. We analyzed several California databases because California's size, representing one in eight students in the United States, and its overall diversity make it particularly useful for testing this analytic approach.^{8,9} Using 4 statewide databases, 2 health, 1 school demographic, and 1 school financial, we developed two models (School District Prevalence and Sociodemographic School District Profiles) to estimate asthma prevalence and revenues lost in each of the 20 largest California School Districts. We also calculated, on a statewide basis, asthma absences by sociodemographic profile, and we categorized all students with asthma by the annual number of asthma days absent (0, 1-2, 3-4, 5-10, 11+), as well as the resultant revenues lost.

METHODS

Data Sources

Annual school district revenue lost due to asthma would best be determined by multiplying the annual number of asthma school days missed by the amount of funding lost per school day missed.

However, no single data source exists that allows for this type of calculation. Neither of the two major California school health data sources, the California Health Interview Survey (CHIS)¹⁰ and the California Healthy Kids Survey (CHKS),¹¹ provide prevalence, sociodemographic, and absence data at the school district level. National databases do not represent the entire state due to the concentration of population in the Los Angeles region. The California Health Information Survey, CHIS data, are not stable below the county level, and the California Healthy Kids Survey, CHKS data, do not have survey questions pertaining to school district level asthma absences. To supplement the health data surveys, we accessed two additional data sets. The California Basic Educational Data System, (CBEDS)¹² provides sociodemographic data by school district. The Average Daily Allowance (ADA) from the California Department of Education, Department of Finance¹³ provides the average amounts paid to school districts for students' daily attendance. Finally, the California Department of Public Health provides a more detailed profile of students with frequent asthma-related school absences, based on the analysis of confidential data from the CHIS survey.¹⁴ Table 1 summarizes details of the five data sources.

Data Analysis

Prevalence rates from the CHIS 2007 and CHKS 2006-08 data sets were compared with those from the National Health Interview Survey.²⁵ Upon determining that all three databases reported similar prevalence rates, but that the NHIS sampling techniques overrepresented the Los Angeles area, the decision was made to use the CHIS and CHKS databases only. Lifetime, rather than current, asthma prevalence rates were used, because only the former were available in the databases.

To present best estimates of local level prevalence rates, school absences, and revenue losses, we developed 2 analytic models (Figure 1). Model 1 uses school district-level lifetime asthma prevalence rates (CHKS data) and school district enrollment numbers from the California Department of Education (CBEDS) to estimate the number of students with lifetime asthma in each school district. This result, multiplied by the statewide average number of asthma-related days missed per student per year (CHIS data), provides an estimate of the total number of asthma days lost to each school district per year.

Model 2 uses concatenated data from the 2005, 2007, and 2009 CHIS surveys to derive statewide averages for the annual number of school days missed by students with asthma, broken down into 18 sociodemographic groups, eg, elementary school non-Hispanic African American boys (Figure 2). Data from CBEDS further provides the population size of public-school children in each demographic group for each school district. Multiplying each school district's subgroup population size by the statewide asthma prevalence rate for that subgroup provides an estimate of the students with asthma in each group for each school district. Multiplying the numbers of students with asthma, as determined above, by the CHIS-derived statewide average number of school days missed for each demographic group in each school district, provides the total number of school days missed annually for students with asthma in each of the demographic subgroups. For each school district, combining the number of days missed for each of its 18 subgroups provides a total of days missed annually for the entire district.

Once school absences are calculated by both models, lost revenues are derived by multiplying the estimated annual number of asthma-related absences for each school district, as determined by each model, by the statewide average lost revenue per day of missed school per student (California Department of Finance ADA data). An ADA adjustment factor, lower limit of 0.762, point estimate of 0.786, and upper limit of 0.815, was then applied to correct for the fact that ADA data are collected for only part of the school year.²⁶ The results provide a point estimate and range of revenue losses by the largest school districts.

Table 1. Data Sources

Type of Data; Name and Source of Data with Brief Description	Years of Data Analyzed	Data Collection Setting	Type of Data Collected	Sample Size/Response Rate	Limitations	Strengths
State-level asthma prevalence rate (lifetime)						
<ul style="list-style-type: none"> - California Health Interview Survey (CHIS)¹⁰ - CHIS is the nation's largest state-based health survey. - CHIS telephone interviewers solicit information from household members on sociodemographic status and health-related variables. - Asthma questions in 2005, 2007, 2009 include: "Has a doctor ever told you that (child/you) have asthma?" - Asthma absence question in 2007: "During the past 12 months, how many days of school did (your child/you) miss due to asthma?" - Children's reports are by proxy (parent or adult in household); adolescents self-reported the number of school days missed.²¹ 	2005, 2007, 2009	<ul style="list-style-type: none"> - Conducted biennially by random-digit telephone dialing. Adults respond for children. - 50,000 households participate per interview year. 	<ul style="list-style-type: none"> - Socio-demographic characteristics, health status and conditions, access to healthcare, and health insurance coverage. Interviews conducted in English, Spanish, and four Asian languages. - All data self-reported for adolescents and adults. - Children's data obtained from adult household member who serves as proxy for the child. - Data stratified by county, and in some cases, by sub-county. In some cases, data from multiple smaller counties are combined. - Data stratified by age and race/ethnicity. 	<ul style="list-style-type: none"> - Sample designs and results by year: 2005;^{15,16} 2007;^{17,18} 2009;^{19,20} - Between 2005 and 2009, the average response rate was 24%. - Detailed descriptions of CHS sampling and survey methods are available.²¹ - Survey development and data collection performed by Westat, a private company specializing in statistical research and large-scale sample surveys under contract with the University of California Los Angeles Center for Health Policy Research. - Samples are weighted to reflect non-institutionalized population for each sampling stratum and for state as a whole. 	<ul style="list-style-type: none"> - In most cases, not able to measure asthma prevalence below the county level; thus, unable to report by school district. - Sample sizes for county-level racial/ethnic groups may be small. - Reports lifetime asthma prevalence data by sociodemographic variables. - Reports on county-level racial/ethnic groups. 	<ul style="list-style-type: none"> - County-level prevalence rates and school absences in last 12 months. - Reports state-level lifetime asthma prevalence data by sociodemographic variables. - Reports on county-level racial/ethnic groups.

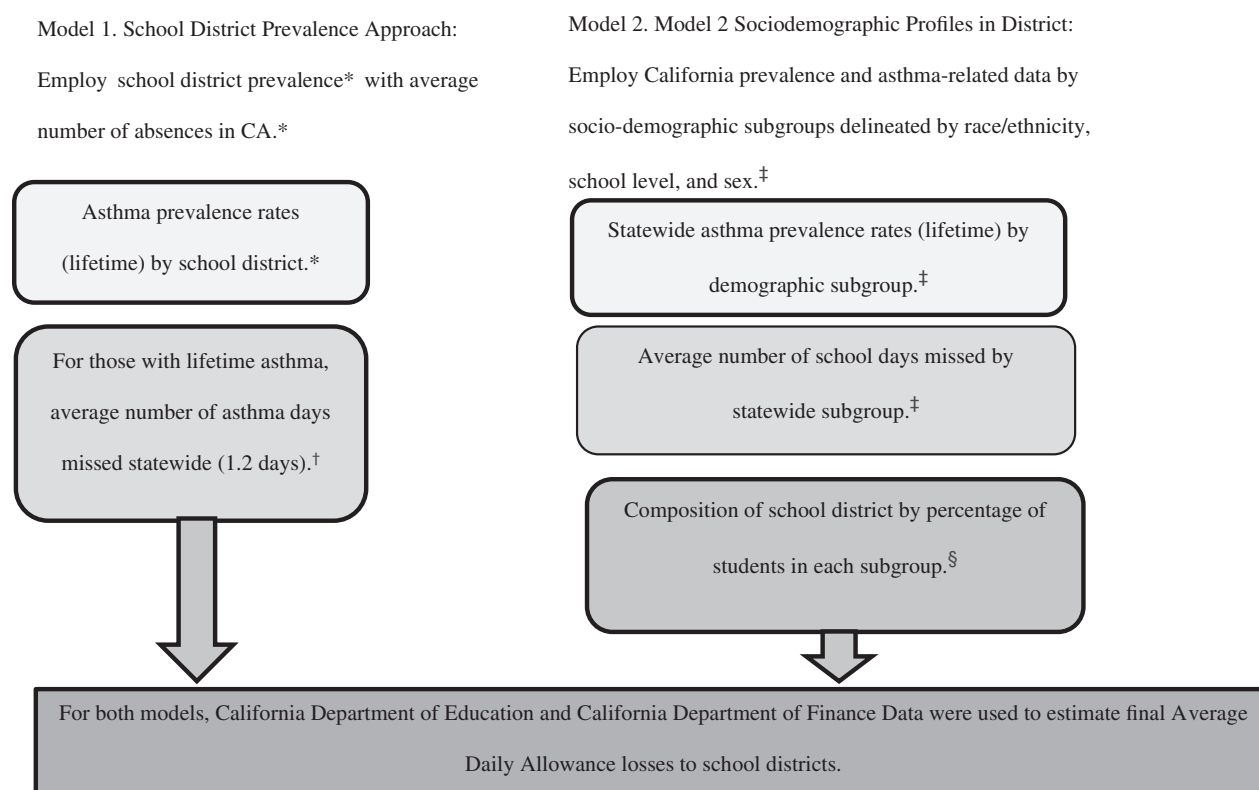
Table 1. Continued

Type of Data; Name and Source of Data with Brief Description	Years of Data Analyzed	Data Collection Setting	Type of Data Collected	Sample Size/Response Rate	Limitations	Strengths
School District asthma prevalence rate (lifetime) - California Healthy Kids Survey (CHKS) ²² - CHKS is the largest statewide survey of youth risk behavior and resilience factors. - Separate elementary, middle, and high school surveys. All self-reported data were acquired from written or web-based questionnaires. - Elementary school questions include: "When not exercising, do you ever have trouble breathing (for example, wheezing, or a sense of tightness in your chest)?" "Has a parent or some other adult ever told you that you have asthma?"	2006-08 or 2005-07	- Surveys are administered to all students in selected classrooms, under informed consent.	- Self-reported data on health-related and risk-related issues. - Elementary school survey represents students in grades 4-6 only. Middle school version represents grades 7-8. High school version represents grades 9-12. - Elementary school students were given a single "core" module (Module A). - Middle and High school students all completed Module A. At each school's discretion, students completed all, some, or none of the 7 optional modules (B-H). - Asthma questions were moved from Module A to optional Module E during the study period. ²³	- Sampling and data collection conducted by WestEd, which generally employs a three-stage sampling design. - Data are unweighted at the school district level, but cumulative district data are weighted to give state estimates.	- Removal of asthma questions from "core" Module A during study period.	- School-district level asthma prevalence data.
Sociodemographic data by school district - California Department of Education: The California Basic Educational Data System (CBEDS). ²⁴ - Annual data on student sociodemographics in California public schools at the county and school district-levels.	2010-2011	- Data on K-12 students collected each October by District and County Offices of Education.	- Socio-demographic data, poverty level, school discipline, graduation rates, etc.	- All counties and school districts required to report.	- Distribution of free and reduced-price school lunches are a proxy measure for poverty.	- Compiled and reported annually from each school district or county. - Sociodemographic data reported by school district.

Table 1. Continued

Type of Data; Name and Source of Data with Brief Description	Years of Data Analyzed	Data Collection Setting	Type of Data Collected	Sample Size/Response Rate	Limitations	Strengths
Costs of Absences to District - California Department of Education, Department of Finance. Calculation of Average Daily Allowance (ADA). ¹³	2009-2010	- School district or county office of education.	- Revenues paid to school districts based on student attendance.	- Calculations based on all California school districts.	- Statewide average for absences.	- Provides an average dollar amount to quantify average revenue loss to school districts due to school absences. - Also, provides an adjustment percent, since ADA is only calculated for a portion of the school year.
Asthma-related Absence Data - California Department of Public Health, Environmental Health Investigations Branch. ¹⁴ - Analysis of confidential CHS files for profiles of student absences (Models 1 and 2).	2009	- See CHS above.	- Uses confidential CHS data files to more accurately determine number of school days lost per student per year due specifically to asthma.	- See CHS above.	- Limitations of CHS data as above.	- Provides more specific data on school days lost by students with frequent episodes of asthma.

Figure 1. Two Models to Calculate School District Asthma Absences and Lost Revenue Note: *CHKS; †California Breathing, California Department of Public Health analysis of confidential CHIS files; ‡CHIS; §CBEDS.



*CHKS; †California Breathing, California Department of Public Health analysis of confidential CHIS files; ‡CHIS; §CBEDS

Ranges of average school days missed and of revenues lost were calculated with 95% confidence intervals using SAS statistical software.

RESULTS

California statewide overall asthma prevalence was 18% in both the CHIS and CHKS surveys. Prevalence by sociodemographic categories in the two surveys were, respectively: Hispanic 17% and 16%; white 18% and 22%; African American 27% for both; American Indian/Alaskan Native 35% and 26%; Asian 17% and 18%; and other 24% (CHIS data only).

Table 2 compares the prevalences and attributable lost attendance revenues for the 20 largest school districts in California, as determined by Model 1 and Model 2. School districts are presented in descending order of size.

Employing Model 1, the lowest asthma prevalence among the largest school districts was 12% in Santa Ana Unified and the highest was 28% in Clovis. Most of the districts clustered in the 17% to 21% prevalence range. Similarly, lost school revenues for the districts ranged from almost \$269,000 for Fontana Unified, the fourth smallest district, to over \$4.5 million for the Los Angeles Unified District, the largest.

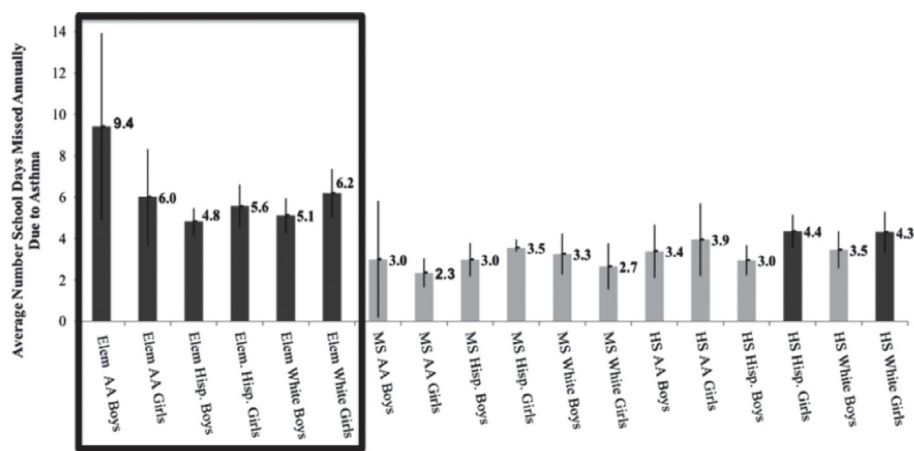
Employing Model 2, which calculated prevalence and lost revenues using sociodemographic school district profiles, the prevalences clustered in a much smaller range of 15% to 20%. Lost revenues, ranged from a low of \$109,852 for Kern Union High, the second smallest district, to almost \$4.4 million for the Los Angeles Unified District. As Figure 2 shows, African American elementary school boys have the highest average number of absences, at 9.4 days per year. All elementary school students had higher absence rates than middle and high school students.

Table 3 presents asthma absences and revenue losses according to the number of school days missed. The 18% of students with asthma who missed three or more days of school accounted for 88% of annual asthma-related ADA revenue losses, or \$26 million.

DISCUSSION

In this study, we employed two models to estimate asthma-related absences and extrapolate their attendant lost revenues for the 20 largest school districts in California. Model 1 performed straightforward calculations, using school district enrollment numbers, asthma prevalence rates, and a statewide average of number of school days missed

Figure 2. Averages of Asthma-related Absences per Year by School Level, Race/Ethnicity, and Sex



95% Confidence Intervals for those missing at least 1 day of school, by Race/Ethnicity, School Level, and Sex (CHIS 2005-2009 Data).

Elem – Elementary; MS – Middle School; HS – High School; AA – African American; Hisp. – Hispanic.

Dark grey bars represent subgroups missing more than 4 days, on average.

annually by students with asthma. Model 2 employed more complex calculations, determining absences and lost revenues for each of 18 sociodemographic subgroups (school level, race/ethnicity, and sex), and then totaling the appropriate subgroup numbers to determine the results for each of the 20 school districts.

Profiles of students' absences due to asthma by sociodemographic group provide guidance to schools for tailoring early treatment and intervention. As Figure 2 reveals, African American, Latino, and white elementary school students had, on average, ≥ 4 absent days per year due to asthma. For boys and girls, respectively, African American students lost an average of 9.4 and 6 days; Latino students, 6 and 4.8 days; and white students, 5.1 and 6.2 days. It would appear that African American schoolboys are an important group for focused interventions due to their particularly high rate of asthma absences. The high rate of asthma absences among white elementary school students is surprising and warrants further investigation.

These profile findings are important because, whereas California's African American population is declining, its Hispanic/Latino population is rapidly increasing, now representing 39% of the population (approximately 15 million people).²⁷ It is estimated to increase to twice its current size by 2050, creating a strong public health, as well as economic, imperative to address asthma in this population.²⁸

Profile analyses are important because both sociodemographic and local environmental factors are key

contributors to asthma. The racial/ethnic disparities revealed by such analyses provide an impetus to reduce the health and educational inequities created by the uneven prevalence of asthma among vulnerable populations. These results also illustrate the need to collect local data uniformly, ideally down to the individual school level, for improved health and educational planning.

The relationship between asthma absences and poor academic performance, school failure, and school dropout has been well documented.^{3,29,30} Furthermore, school dropout, due to asthma and other causes, may lead to introduction into the juvenile justice system.³¹ In terms of financial losses, it is estimated that high school dropouts cost the California economy \$46.6 billion annually.³²

Table 3 shows that only 29.7% of students with asthma missed any school days due to the condition. However, those missing five or more days per year, 36% of those with asthma absences, account for 71% of school revenues lost to asthma, approximately \$20.8 of \$29.2 million. Our data do not allow further categorization of this group, but more detailed study of these "frequent flyers" would allow schools and school districts to better define, and focus treatment and prevention efforts on, this high-risk group.

This analysis represents an attempt to extract more useful data from limited, uncoordinated data sources. It supports the assumption that asthma in school-aged children poses substantial economic, as well

Table 2. Lifetime Asthma Prevalence and Attributable Average Daily Allowance (ADA) Loss to 20 Largest School Districts in California by 2 Models

School District	Model 1: Prevalence and Attributable ADA Losses Calculated Employing School District Prevalence			Model 2: Statewide Prevalence and Attributable ADA Losses Calculated Employing Race/Ethnicity, Age, and Sex Categories in School Districts		
	Asthma Prevalence	Lost ADA Revenue	95% Confidence Interval for ADA loss	Asthma Prevalence	Lost ADA Revenue	95% Confidence Interval for ADA loss
20 Largest School Districts						
Los Angeles Unified	17%	\$4,531,425	(3,221,578-6,264,821)	16%	\$4,388,282	(2,539,565-6,852,047)
San Diego Unified	19%	\$1,031,383	(733,253-1,425,916)	17%	\$717,804	(403,657-1,141,443)
Long Beach Unified	21%	\$717,082	(509,804-991,386)	18%	\$508,510	(272,509-832,021)
Fresno Unified	20%	\$619,631	(440,521-856,657)	17%	\$448,169	(256,868-704,135)
Elk Grove Unified	23%	\$585,191	(416,036-809,042)	19%	\$284,576	(145,159-478,762)
Santa Ana	12%	\$278,859	(198,253-385,530)	15%	\$361,474	(229,251-530,194)
San Francisco Unified	18%	\$405,997	(288,640-561,302)	18%	\$174,188	(88,584-292,905)
San Bernardino City	19%	\$426,086	(302,922-589,076)	17%	\$360,533	(198,369-580,674)
Capistrano Unified	18%	\$380,214	(\$270,310-525,656)	17%	\$253,755	(162,545-369,349)
Corona- Norco	20%	\$426,169	(302,981-589,190)	17%	\$287,518	(171,344-440,640)
Garden Grove	16%	\$315,367	(224,207-436,003)	16%	\$193,271	(121,002-285,902)
Sacramento City	19%	\$365,563	(259,894-505,402)	19%	\$268,998	(135,033-459,142)
San Juan Unified	23%	\$439,678	(312,586-607,868)	18%	\$240,849	(142,075-371,273)
Oakland Unified	21%	\$401,915	(285,738-555,659)	20%	\$329,353	(148,153-587,385)
Riverside Unified	20%	\$339,833	(241,602-469,829)	17%	\$245,274	(143,797-380,000)
Sweetwater Union	17%	\$288,788	(205,304-399,243)	17%	\$239,886	(130,335-386,155)
Fontana Unified	16%	\$269,917	(191,895-373,167)	16%	\$265,179	(158,422-405,648)
Stockton Unified	20%	\$317,572	(225,775-439,053)	17%	\$225,128	(125,921-359,165)
Kern Union High	20%	\$311,011	(221,111-429,981)	20%	\$109,852	(49,330-192,879)
Clovis Unified	28%	\$430,500	(306,060-595,178)	17%	\$181,767	(112,652-271,105)

Table 3. Asthma's Impact on Absences and ADA[†]Revenue in California

Days Absent from School Due to Asthma	Percentage of Students with Asthma per Absence Category (95% Confidence Interval Range)	Estimated Number of Asthma-Related Absences (95% Confidence Interval Range)	Estimated ADA Revenue Lost [†] (95% Confidence Interval Range)
0	70.3 (65.1-75.4)	0	\$0
1 or 2	11.4 (7.3-15.5)	141,438 (± 32,316)	\$3,704,193 (± 846,341)
3 or 4	7.5 (5.2-9.9)	183,590 (± 28,978)	\$4,832,603 (± 758,920)
5-10	7.8 (4.4-11.1)	354,246 (± 77,537)	\$9,324,747 (± 2,030,657)
11+	3.0 (1.2-4.9)	436,079 (± 159,227)	\$11,478,820 (± 4,752,455)
Total		1,115,353 (± 181,464)	\$29,210,560 (± 4,752,455)

[†] ADA, Average Daily Allowance.

as societal costs. For the many school districts that previously had no data on their asthma-related school absences, it provides estimated ranges for absences and costs, allowing districts to formulate treatment and prevention policies.

Our findings also have ramifications for future research. Documenting variations in asthma prevalence rates by district provides justification for extending the locus of analysis to the individual school level, where data on asthma-prevalence and absences might lead to identifying neighborhood asthma-risk factors, or even indoor air quality issues in the schools themselves. These issues become even more important when one considers co-morbidities of asthma, including obesity, obstructive sleep apnea,

stress, and depression, and their effect upon student health and school absences.³³

Finally, the prevalence of asthma among ethnic/racial groups of students needs to be recognized as a major contributing factor to health and academic disparities. As schools and communities consider their responsibility to respond to inequities in academic outcomes, a systematic response to asthma, particularly as a contributing factor to school absences, may be an important nexus point for further action.

Limitations

Local level data sets for estimating school asthma absences and lost revenues are lacking. Available

datasets in California and many other states do not include sociodemographic information at the district level. To assess absences and lost revenues, we employed projections and extrapolations to compensate for the lack of relevant variables at the school district level. Given the limitations of each dataset, we provided conservative estimates with ranges, allowing for flexibility in interpretation.

Because we used datasets that varied in sample size, information collected, and year(s) of data collection, we aggregated data over a 4-year period to add stability to the data, rather than trying to capture one narrow period in time.

Asthma prevalence rates used in Models 1 and 2 derive from self or proxy reports rather than from objective data. This can introduce recall bias, especially for questions that ask students or their parents to remember how many asthma-related absences occurred over the previous 12 months. Questions in both CHIS and CHKS surveys ask if a doctor has ever told you or your parent that you have asthma. Underreporting may occur among those with limited access to medical care, and will certainly occur among those who, indeed, have asthma but have never received a formal diagnosis.

Another limitation arises from the fact that response rates to CHIS questions ranged from only 20% to 27% for the 2005, 2007, and 2009 surveys.³⁴⁻³⁶ Furthermore, during the 2005-2007 CHKS survey, asthma-related questions for secondary school students were moved from the required “core” survey module to an optional module. Many school districts stopped administering this optional module altogether; for those districts that did administer it, over half had response rates below 60%, a threshold below which CHKS considers the data not necessarily representative of the area.³⁷

Finally, district-level calculations of asthma-related school days missed are based on data from dissimilar populations. In Model 1, for example, asthma prevalence rates are available for each school district, but the average number of asthma days missed per student with asthma is a statewide average of all students in all school districts. Accurate determination of district-level annual absences and revenues lost would best come from data derived from students in each individual school district.

Conclusion

In this study, we provided estimates of asthma school absences for the 20 largest California school districts and for selected sociodemographic groups in these districts. It also estimates the revenues lost to school districts due to these absences. Although the analysis was conducted using limited data sources, the results obtained from the two assessment models are

largely concordant suggesting that the estimates and ranges warrant consideration.

On a statewide basis, the 36% of students with asthma absences who missed ≥ 5 school days annually due to this condition accounted for 71%, or \$21 million of the asthma-absence revenues lost by California's 20 largest school districts. Subgroup analysis revealed that African American elementary school boys accounted for a disproportionately large portion of this amount. These data, limited as they are, are our best approximations of the large economic impact of school days lost to asthma. They also illustrate the need for more refined data sets, especially at the school district level, and ideally down to the individual school level, to effectively define and ameliorate the social and economic costs of school-age asthma.

IMPLICATIONS FOR SCHOOL HEALTH

The Healthy People 2020 Respiratory Disease objectives numbers 5-7³⁸ refer to reducing asthma absences, increasing asthma education, and increasing asthma treatment according to National Asthma Education and Prevention Program guidelines.³⁹

Asthma absences contribute to lost school district and community revenues, as well as to reduced opportunities for improving educational attainment and societal equity.⁴⁰ There are a number of constructive approaches that can be tailored to the individual characteristics of schools and districts. Several of these are discussed in the following paragraphs.

Given that students who have 3-5 or more asthma absences annually account for most of the asthma absence revenue lost, school districts, and even individual schools, might focus upon this cohort of students to maximize their impact. The Minnesota Department of Health asthma program provides a guide that draws upon resources from national organizations focused upon asthma and attendance.⁴¹

Because elementary school children have higher rates of asthma absences than older students, this group merits particular attention. Within this cohort, African American boys have considerably higher asthma absences rates than other racial or ethnic subgroups. Accordingly, this group should have high priority in future studies and intervention plans.

Asthma action plans can be employed to monitor and educate students with asthma. These plans enable school personnel, physicians, caregivers, and students to share important information about students' asthma conditions and medications. A number of organizations provide free downloadable templates.⁴² The American Lung Association provides versions in both English and Spanish, as well as home and school versions.⁴³ Schools without school nurses or clinics can

encourage students and their caregivers to coordinate these action plans with physicians and school staff.

School nurses and school-based health centers can provide on-site personnel who can assist in asthma monitoring and treatment. Unfortunately, the trend, in some places, has been to reduce the number of school nurses.⁴⁴ A number of organizations and authors provide guidance and assessments of these strategies.⁴⁵⁻⁴⁹

Indoor and outdoor asthma environmental trigger education can be implemented, depending upon school resources. In a number of California schools, the low-cost intervention of employing a color-coded flag indicating outdoor air quality led to increased awareness of environmental triggers and of appropriate activity levels for students with asthma.⁵⁰

Employing a medical social model for asthma care has been successful in educating children and their caregivers about medical management and environmental triggers.⁵¹ Although successful at stabilizing students with asthma, these programs can be resource intensive and require careful planning for implementation.⁵²

Because asthma inequities are affected by a number of individual-, community-, and system-level factors, population approaches to research and intervention are promising avenues. These factors include health care, health insurance, and health policy, as well as student, family, and environmental factors.⁵³ Additional areas include improving primary and specialty care and health literacy. Whereas the programs focusing upon asthma action plans, environmental remediation in the home, and education for students and families have had some success, more comprehensive and sustainable programs are warranted. Important areas for investigation include:

- How can schools with limited resources effectively coordinate care?
- How can education be consistently tailored for cultural groups?
- How can insurance companies support access to care and medications?
- What financial incentives can provide approaches that reduce inequities?
- How can multilevel systems of education and care based on risk profiles be employed to improve asthma disparities?

Focusing upon high-risk students can lead to economic savings increasing school attendance and achievement.

Human Subjects Approval Statement

The Institutional Review Board of the University of California San Francisco approval number: H5352-31157-02.

Conflict of Interest

The authors have no conflict of interest to declare.

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